Thunderstorms occur when gradients disappear with change of gradient, for instance, occasionally, before a typhoon; when the weather is hot; and especially, when the wind is northwest and it is very hot inland in China. Mr. Figg has sometimes noted jumps in the barometer readings before as well as during thunderstorms. He states that when they approach from the landside there is very little rain, while if they come up from the seaside there is great rain.

SELENIUM AND ITS USE FOR THE MEASUREMENT OF SUNSHINE.

By N. ERNEST DORSEY, Ph.D., of Johns Hopkins University (dated April 17, 1899).

Owing to frequent inquiries as to the suitability of some form of the selenium cell as a continuous and exact sunshine recorder, it has been deemed advisable to publish in this REVIEW a short account of what is known in regard to the selenium cell, especially with respect to this use.

The fact that the resistance of selenium is changed by the action of light was first announced by Willoughby Smith in 1873. He wished to use selenium bars with platinum wire electrodes melted into their ends as high resistances to be used in connection with submarine cables. His assistant found that the resistances of these bars were very inconstant, and this variability was found to be due to the varying illumination of the bars. It was found that the decrease of resistance noticed when the bars were illuminated was due to the visible radiation, and appeared to be instantaneous. Smith suggested that this effect might possibly be explained by the fact that selenium conducts electricity only when in the crystalline condition, and that light favors crystallization.

Immediately upon the publication of Smith's paper Lieutenant Sale, and also the Earl of Rosse, repeated and verified Smith's observation. The latter suggested that this property of selenium might be used as a means of measuring the intensity of light, as he found that the decrease of resistance is almost proportional to the square root of the intensity of the illumination.

In 1875 Werner Siemens went over this work again and then undertook the study of the effect of the physical state of the selenium upon its sensitiveness to light. He found that by protracted heating of amorphous selenium at 210° C., or by cooling melted selenium to this temperature (at which, with a longer duration of it, the selenium passes into a coarsely granular, crystalline state), he obtained a modification of crystalline selenium which possesses and retains a considerably greater conductivity than otherwise. It is also far more sensitive, and the decrease of its resistance due to its exposure to light appeared to be constant. He constructed the first of the so-called selenium cells, which he describes as follows: "By fusing into coarsely granular selenium two flat spirals of wire at the distance of about one millimeter from each other, I produced an extraordinarily sensitive photometer." Obscure heat rays were without effect upon this cell, while diffused daylight doubled its conductivity, and direct sunlight increased its conductivity, at times, tenfold.

Prof. W. G. Adams and R. E. Day now undertook investigations on this subject and in 1877 they published in the Philosophical Transactions a long and exhaustive article on the subject. Besides obtaining results similar to those already described, they found that the resistance of the selenium cell generally decreased with an increase of the current through it, and depended upon the direction of the current. They also found that the cells became polarized on the passage of a current; that the change of resistance due to illumination depended upon the end illuminated; that when no current was passing through the cell the action of light on the cell could give rise to a current through it, but in regard to this latter property they say:

It appears that three pieces of the same length, made from the same rod, and annealed together may, owing to some slight difference in molecular condition, be very different as to their relative sensitiveness to the action of light.

It was also observed that a slight heating produces a great increase in the resistance, which also changes very greatly with the time; they appear to anneal slowly.

In 1878 Sabine studied the resistance of the fused-in electrodes and found that it was very great and depended upon the direction, strength, and duration of the current passing through the cell.

In 1884 C. E. Fritts described a new form of the selenium cell which is much more sensitive than any of these others. He melts a thin layer of selenium upon a metal plate with which it will form a chemical combination at least sufficient to cause the selenium to adhere to it and make good electrical connection, the other surface of the selenium is covered with a transparent conductor, generally gold leaf, through which the current is passed into the selenium. Like other kinds of selenium cells the resistance of these depends upon the strength and direction of the current and the temperature and age of the cell.

In 1888 Uljanin investigated this subject and explained the observed phenomena much in the same way as Smith first suggested. He assumed that the annealed selenium consists of various allotropic forms of selenium, some of which are conductors and some are not, and the action of light is supposed to favor the change from one form to the other. He gives a good résumé of the work up to this time.

In a series of articles published in the Philosophical Magazine, from 1881 to 1895, Bidwell points out that all the properties of the selenium cells which have been so far discovered suggest that the conduction through these cells is electrolytic in character. The selenium is probably a nonconductor, and the current is carried by metallic selenides contained in the selenium. In support of this he finds that selenium which has never touched metals but has been annealed in glass has a much higher resistance than that annealed in the ordinary way; and, furthermore, its resistance is decreased by the addition of metallic selenides, so that it behaves like ordinary selenium. He also found that certain specimens of selenium which were entirely insensitive to light, were rendered very sensitive by the addition of selenides. And, finally, he succeeded in constructing a cell composed of sulphur and silver sulphide which behaved exactly like the selenium cell. His last article, published in the Proc. Phys. Soc. 13, 1894, pp. 552–579, and Phil. Mag. (5) 40, 1895, pp. 233–256, contains the best and most recent résumé of the entire subject.

From this we see that while selenium cells may be used for very rough determinations of the intensity of illumination, they are eminently unsuitable for any exact photometric work. Owing to the fact that the resistance varies with the strength and duration of the current, and with the temperature, and with the entire past history of the selenium, each cell would have to be carefully studied in order to obtain the coefficients of these various factors, and after this was done these coefficients would be correct for but a very short time, on account of the unknown and variable change of the resistance and electromotive force of the selenium cell with its age.

The best articles on this subject are as follows: Willoughby Smith, Nature, 5, 1873, pp. 303 and 361; Am. Jour. Science, (3) 5, 1873, p. 301. Lieutenant Sale, P. R. S., 21, 1873, p. 283; Pogg. Ann., 150, p. 333; Phil. Mag. (4) 47, 1874, p. 216; Earl of Ross, Phil. Mag. (4) 47, 1874, p. 161; Werner Siemens, Monatsberichten der kön. preuss. Akad. d. Wissenschaften zu Berlin, 1875, p. 280; Phil. Mag. (4) 50, p. 416; Pogg. Ann., 149, p. 140; W. S. Adams and R. E. Day, Phil. Trans., 167, 1877, pp. 313–349; Proc. Roy. Soc., vols. 23, 24, 25; Sabine, Phil. Mag. (5) 5, 1878, p. 401; Bell, Proc. A. A. A. S., 29, 1880;

Dr. James Moser, Pro. Phys. Soc. 4, 1881, p. 348; C. E. Fritts, Pro. A. A. A. S., 33, 1884, p. 97; Scientific American Supplement, June 6, 1885, p. 7854; Bidwell, Phil. Mag. (5) 5, 1881, p. 302; 15, 1883, p. 31; 13, 1882, p. 347; 40, 1895, pp. 233–256; Pro. Phys. Soc, 7, 1885, p. 129; 13, 1894, pp. 552–579; W. von Uljanin, Thesis published in Moscow, entitled *Ueber die bei der Beleuchtung entstehende Electromotorische Kraft im Selen;* Morize, Am. Met. Jour. vol. 2, p. 2.

OBSERVATIONS AT HONOLULU.

Through the kind cooperation of Mr. Curtis J. Lyons, Meteorologist to the Government Survey, the monthly report of meteorological conditions at Honolulu is now made nearly in accordance with the new form, No. 1040, and the arrangement of the columns, therefore, differs from those previously published.

Meteorological observations at Honolulu.

MARCH, 1899.

The station is at 21° 18′ N., 157° 50′ W.
Pressure is corrected for temperature and reduced to sea level, and the gravity correction, —0.06, has been applied.
The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, connected by a dash, indicate change from one to the other.
The rainfall for twenty-four hours is now given as measured at 1 p. m. Greenwich time on the respective dates.
The rain gauge, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet, and the barometer 50 feet above sea level.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m., Greenwich time, or 2:30 a. m., Honolulu time, of the respective dates.									
				Temperature.		Means.		Wind.		Total rainfall.	Average cloudiness.	Sea-level pressures.	
		Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Force.			Maximum.	Minimum.
	*	†	†			‡	‡		§				
1.....	30.05	71	63	77	70	62.0	67	nne.	4-6	0.02	7	30.09	30.02
2.....	30.01	71	64.5	77	70	59.5	64	ne.	3	0.09	10	30.08	30.02
3.....	29.91	64	63	79	69	63.3	71	nne.	2-0	0.00	4	30.03	29.89
4.....	29.92	60	59	79	63	64.0	78	w-n.	2-0	0.00	2-7-0	29.95	29.88
5.....	30.00	71	65	78	59	61.3	73	ne.	0-3	0.00	9	30.03	29.93
6.....	29.98	69	65	77	68	62.3	72	nne.	4-6	0.95	8-10	30.08	29.95
7.....	29.95	69	63	69	67	63.3	85	nne.	4-0	1.68	10	30.04	29.94
8.....	29.90	65	63	75	65	61.3	71	ne.	3-0	0.03	6	30.00	29.87
9.....	29.96	65	64	79	64	63.7	78	ne.	2	0.13	6	29.99	29.91
10.....	29.99	65	64	80	65	64.0	81	se.	2	0.00	5	30.04	29.95
11.....	29.98	67	66	81	64	66.5	84	se.	2	0.08	4	30.03	29.95
12.....	29.96	68	67.5	81	66	66.5	81	s.	0-2	1.68	8-10	30.00	29.91
13.....	29.98	70	69	79	68	68.3	88	s-w.	1	0.16	10-7	30.03	29.94
14.....	30.04	72	68	78	69	68.3	84	se-ne.	0-3	0.06	10-4	30.09	30.00
15.....	30.06	69	64.5	80	70	65.7	74	ne.	0-3	0.00	10-4	30.10	30.01
16.....	30.07	62	61.5	78	69	64.0	73	ne.	3	0.00	6-3	30.11	30.01
17.....	30.03	69	64.5	80	62	62.8	75	ne.	3	0.00	4-8	30.09	29.99
18.....	30.00	66	64	79	69	63.5	74	e-se.	3-1	0.00	3-10	30.06	29.96
19.....	29.92	68	67	80	64	65.5	79	sw-w.	2	0.04	6	30.01	29.93
20.....	29.93	61	59	77	67	63.3	79	ne-s-w.	1	0.00	8-10	29.98	29.90
21.....	29.87	58	57.5	79	58	59.7	70	wnw.	1-3	0.00	5	29.94	29.84
22.....	29.84	60	56.5	80	58	57.3	74	wnw.	2-4	0.00	4-0	29.92	29.79
23.....	29.84	64	57	75	57	55.7	68	n.	2	0.00	6	29.90	29.81
24.....	29.86	61	59	77	61	54.3	62	n-se.	1	0.00	4-0	29.92	29.83
25.....	29.90	66	65	77	59	61.7	76	s.	1	0.04	7-0-6	29.96	29.84
26.....	29.98	65	63.5	80	62	65.3	75	s-sw.	1-0	0.00	5	30.02	29.93
27.....	30.02	68	66	81	64	64.3	73	e-ne.	2	0.00	3	30.06	29.98
28.....	30.06	73	66	82	67	66.5	76	ne.	3	0.00	3	30.12	30.02
29.....	30.05	72	65	79	72	64.0	66	ene.	5	0.02	3	30.13	30.04
30.....	30.05	72	65	80	71	61.7	65	ne.	3	0.01	4	30.11	30.04
31.....	30.05	73	63.5	80	69	62.0	62	ne.	3	0.00	2	30.12	30.06
Sums..	......	......	......	.....	.....	.....	.....	....	.....	4.94	.....	....	.....
Means.	29.973	67.0	61.4	78.5	65.4	62.9	74.1	....	.....	....	5.8	30.033	29.940
Departure..	—0.005	......	......	+0.5	+0.5	+2.0	+2.8	....	.....	+0.78	+1.9	—.005	—.005

Mean temperature for March, 1899 (6+2+9) ÷ 3=71.2°; normal is 70.7°. Mean pressure for March is 29.987; normal is 29.982.
* *This pressure is as recorded at 1 p. m., Greenwich time.* † These temperatures are observed at 6 a. m., local, or 4:30 p. m., Greenwich time. ‡ These values are the means of (6+9+2+9) ÷ 4. § Beaufort scale.

METEOROLOGY OF THE YUKON.

Mr. U. G. Myers, Observer, Weather Bureau, who has been spending a year in Alaska on a furlough, sends a copy of a meteorological record made by him at Dawson City (N. 65° 5′, W. 139° 30′; elevation about 1,100 feet above sea level), during November and December, 1898, and January, 1899. Mr. Myers made a daily reading of the barometer and maximum and minimum thermometers, and noted the character of the day. Dawson is about 75 miles southeast of the Weather Bureau station at Eagle (N. 64° 45′, W. 141° 8′).

The following is a summary of his observations:

Month.	Temperature.							Total snowfall.	Depth of snow on ground.		Number of days—			Prevailing direction of wind.
	Maximum.	Date.	Minimum.	Date.	Mean maximum.	Mean minimum.	Mean (max. and min.).		On 15th.	At end of month.	Clear.	P. cloudy.	Cloudy.	
1898.	°		°		°	°	°	*Ins.*	*Ins*	*Ins.*				
November *....	23.3	13	—41.4	19	—10.9	—17.8	—14.4	.....	9.0	12.0	10	8	12	n.
December.....	38.0	6	—41.0	31	3.5	— 7.9	— 2.2	10.0	18.0	22.0	16	12	3	n.
1899.														
January	2.0	21	—45.0	25	—15.7	—27.2	—21.4	6.0	24.0	28.0	11	4	16	n.

* For 29 days.

November, 1898: Yukon closed at 9 p. m. on the 3d. Snowfall on the 10th, 24th, and 26th.

December, 1898: Light rain for a few minutes during afternoon of the 6th. Light snow fell on the 1st, 2d, 3d, 14th; heavy snow on the 15th, 22d, and 24th.

January, 1899: Light snow on 9th; heavy snow on 28th.

SNOW ROLLERS.

By A. H. THIESSEN, Observer Weather Bureau.

As a slight contribution to the literature of natural snowballs the following will be of interest.

Mr. Walker, a voluntary observer at Dearborn Canyon, Mont., sent in the following remark with his January report:

On the 27th at 9 a. m. a high west wind began blowing that caused the moist snow to roll along the ground and form large snowballs, until the fields and pastures looked as if Mother Nature had been amusing herself on a large scale.

Mr. Walker has since been in the Helena office and a more detailed description has been secured. The scene of this phenomenon was a rolling field. Six inches of very light snow fell the day before. At the time of the phenomenon the observer judged that the temperature was about at the freezing point. The wind was blowing a gale, estimated at 40 miles per hour. The snow was lifted up in sheets before it began to roll, just as one would roll a sheet of paper. The balls were of all sizes, and were formed on the upgrade as well as on the down. They were even forced over a small knoll and were then assisted by a gravity into a hollow where many were collected. No very reliable data could be obtained as to structure. The small balls were spherical and the larger ones were cylindrical. There was also a hole through the center three to six inches in diameter. Later in the day a chinook reached the station dissipating the snow and leaving these monuments for awhile showing what rare and singular conditions may occur in nature.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined list of titles has been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index